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GUIDE TO THE RENEWABLE ENERGY REPORT LIBRARY

INTRODUCTION

The Montana Department of Natural Resources and Conservation (DNRC) and the Montana State Library are cooperating to bring current information on renewable energy projects and research to Montanans. A collection of reports from DNRC's Energy Division files is being offered for public use through the Montana State Library.

This booklet contains abstracts of the reports, with project locations, energy resources, report authors and dates, suggested audiences, and topics discussed. Information on how to order the reports is given below.

BACKGROUND

The reports available through the report library were written as requirements for projects funded wholly or partially under The Renewable Energy and Conservation Program or the Biomass Utilization and Cogeneration Program. This collection was established to help meet DNRC's aim of sharing with the public the knowledge and information gained through these programs. The 63 reports selected for inclusion in the collection are unedited final project reports containing generally useful, descriptive information on what energy concepts and systems do and don't work in Montana.

The Renewable Energy and Conservation Program is funded by Montana's coal severance tax. The program was established to reduce the state's reliance on fossil fuels through the increased use of conservation, solar, wind, geothermal, small-scale hydro, and biomass energy alternatives. Through this program, DNRC offers grant and loan funding for eligible projects.

The Biomass Utilization and Cogeneration Program is funded by the U.S. Department of Energy and is administered by the Bonneville Power Administration through a grant awarded to the State of Montana. Under the grant, Montana offers funding for technical assistance to biomass energy projects conducted in western Montana within the Bonneville Power Administration's service area.

HOW TO ORDER

The reports described in this booklet may be borrowed by any adult public library card holder in the United States. All requests must be sent through a public library. The report will then be ordered from the Montana State Library on interlibrary loan.

When placing an order, please provide your library with the following information.

Name of Collection: Renewable Energy Report Library
Report Title
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NOTICE

The following reports were prepared through projects sponsored by the Montana Department of Natural Resources and Conservation. The reviews and opinions of authors expressed in the reports are not necessarily those of the Department or any Department employee.

WE WISH TO THANK THE MONTANA STATE LIBRARY FOR THEIR COOPERATION IN THIS PROJECT.

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SOLAR
Active Systems

TITLE: ACTIVE LIQUID SOLAR SYSTEM

I.D. NUMBER: 058-761

REPORT AUTHOR: James Coons

DATE WRITTEN: March 1980

PROJECT LOCALE: Billings

TOPICS: Closed-loop, active, hydronic, domestic hot water, space heat

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The planning and installation of a hydronic system using a mixture of one part water to one part ethylene glycol is discussed. The fluid circulates in a closed loop from 600 square feet of collectors into two 1,050-gallon storage tanks. A detailed listing of system components, prices and suppliers, and construction timeline is included, as well as an economic analysis of the system, schematic diagrams, and manufacturers' specifications.

TITLE: SOLAR TRICKLE SYSTEM INTEGRATED WITH WOOD HEATING

I.D. NUMBER: 100-771

REPORT AUTHOR: Philip & Blanche Pallister

DATE WRITTEN: February 1981

PROJECT LOCALE: Boulder

TOPICS: Integrated system, trickle collectors, water-jacket fireplace, water tank, thermal storage

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The major features of a solar and wood heating system are discussed. The report deals with problems that arose during system construction and operation, and outlines solutions to these problems. Particularly useful are descriptions of the integrated solar and wood system for space and domestic water heating, and use of a prefabricated bivalve septic tank for thermal storage. Schematic drawings are included.

TITLE: ACTIVE SOLAR RETROFIT

I.D. NUMBER: 101-771

REPORT AUTHOR: Dennis Howard

DATE WRITTEN: January 1982

PROJECT LOCALE: Glendive

TOPICS: Active solar air collectors, remote rock storage

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The installation of a remote solar furnace, a free-standing structure that houses 160 square feet of solar air collectors and 400 cubic feet of oversize rock for thermal storage, is described. The construction of the system is treated in detail, and five years of annual reports on performance of the system are included. Each report contains heating bill records and charts of energy consumed throughout the year, comparing heating with the solar furnace to heating prior to installation of the solar system. Newspaper articles and manufacturers' specifications are also included in the report, as is a detailed project timeline.

TITLE: SOLAR DOMESTIC HOT WATER FOR AN 84-UNIT APARTMENT

I.D. NUMBER: 145-771

REPORT AUTHOR: Major T. Caldwell

DATE WRITTEN: August 1979

PROJECT LOCALE: Conrad

TOPICS: Solar domestic hot water, retirement home, closed-loop, flatplate, commercial size

SUGGESTED AUDIENCE: Architects, engineers, designers, general public

REPORT SUMMARY: The installation of a large closed-loop domestic hot water preheat system that provides hot water to a retirement building is described. The report discusses the flatplate collectors selected, and addresses the costs, acquisition, performance, and a brief economic evaluation of the system components. The report includes descriptions of the modifications made to the system design while the project was under construction.

* NOTE: Working drawings of the system are on file at DNRC.

TITLE: SOLAR DOMESTIC HOT WATER SYSTEM

I.D. NUMBER: 060-811

REPORT AUTHOR: Marcus McBeen

DATE WRITTEN: August 1981

PROJECT LOCALE: Gardiner

TOPICS: Free-standing drain-back system, absorber plates, insulation

SUGGESTED AUDIENCE: General public, engineers, builders, plumbers

REPORT SUMMARY: The development of a low-cost solar water heating system is discussed. Materials used in construction of the system, as well as suppliers of these materials are listed. Detailed descriptions are included for collector absorber plates, collector housing, storage tank, tank insulation, pipe insulation, and collector support structure. Design and installation are covered in detail, as are problems and modifications. Schematic diagrams, manufacturer's specifications, budget information and performance data for the system are included.

TITLE: CONSTRUCTION OF A SOLAR SCHOOL BUILDING AND SOLAR RETROFITTING OF AN EXISTING SCHOOL BUILDING

I.D. NUMBER: 032-821

REPORT AUTHOR: Tim Schaff, Larry Drake

DATE WRITTEN: July 1983

PROJECT LOCALE: Park City

TOPICS: "In-slab" solar heating, active solar heating, heat exchangers

SUGGESTED AUDIENCE: General public, builders

REPORT SUMMARY: This report discusses the installation and operation of a new school building heated by a solar hot water system with radiation from the concrete floor slab. The heat exchangers installed in the forced air furnace that provide heat to an existing building are described. Also included is an energy and economic analysis and a discussion of system monitoring.

* NOTE: Working drawings of the system layout are on file at DNRC.

TITLE: AN ENERGY SELF-SUFFICIENT SPACE AND WATER HEATING RETROFIT PROJECT

I.D. NUMBER: 104-811

REPORT AUTHOR: Russell R. Hansen

DATE WRITTEN: March 1982

PROJECT LOCALE: Lewistown

TOPICS: Retrofit, rock storage, thermosiphon greenhouse, woodstove, storage

SUGGESTED AUDIENCE: General public, builders

REPORT SUMMARY: The installation and operation of an energy system incorporating solar and wood energy for a seventy-year old house in central Montana is described. A thermosiphoning loop from the wood stove heats domestic hot water in conjunction with an active solar system; convective heat from the stove can be directed to rock storage or a solar greenhouse, and heat from the greenhouse can be vented into the living space.
Included is a list of general suppliers of the equipment used in the system.

TITLE: SOLAR MOBILE HOME HEATING

I.D. NUMBER: 048-772

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: September 1979

PROJECT LOCALE: Bozeman

TOPICS: Performance monitoring, rock box storage, vertical wall collectors

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: A factory-built mobile home was modified to accommodate a solar-wood-electric system that uses a rock box storage. The report describes the design and construction phases of the project and presents the details of the performance monitoring of the system. Also included is the instrumentation layout, a discussion of the results, conclusions, and recommendations.

* NOTE: Raw data of the system's daily performance from January-July 1979 is on file at DNRC.

SOLAR
Passive Systems

TITLE: PASSIVE SOLAR HOME

I.D. NUMBER: 045-761

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: February 1978

PROJECT LOCALE: Bozeman

TOPICS: Passive solar water wall, insulating curtain, domestic water preheat, wood backup

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The construction of a passive solar home, using large water-filled columns located directly inside extensive south glazing is described. The report lists materials used and discusses construction techniques and problems. Schematic diagrams and photographs are included. A detailed description of the passive system's large, mechanized insulating curtain and a discussion of the active solar domestic water preheating system are also included.

TITLE: PASSIVE SOLAR/EARTH-SHELTERED HOUSE

I.D. NUMBER: 032-781

REPORT AUTHOR: John R. Means

DATE WRITTEN: August 1980

PROJECT LOCALE: Missoula

TOPICS: Passive solar, domestic hot water heat, Trombe wall, earth-sheltered

SUGGESTED AUDIENCE: General public, architects, engineers, builders

REPORT SUMMARY: The report summarizes the design, construction and monitoring of a passive solar, earth-sheltered home. It includes a thorough discussion of construction techniques and problems, materials used, and architectural drawings. Specific components addressed in the report include the Trombe wall, the house floor plan, the south glazing, reflective surface and insulating curtain. Unlike most passive solar/earth-sheltered homes, this project is located on a north-facing slope; the report details specific design considerations for obtaining adequate passive gain in this orientation.

* NOTE: Working drawings of the floor plan are on file at DNRC.

TITLE: PASSIVE HEATING, LIGHTING AND COOLING OF A PUBLIC MULTI-USE FACILITY

I.D. NUMBER: 725-811

REPORT AUTHOR: Jay Kirby

DATE WRITTEN: December 1982

PROJECT LOCALE: Pablo

TOPICS: Passive solar energy, earth berming

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design and construction of a student services center at Salish-Kootenai College is described. The report summarizes the various alternative energy strategies for heating, cooling and lighting that are incorporated into the structure. These strategies include earth berming, heat storage in stone and concrete walls and floor, the use of curtains for window insulation and light control, and a wood stove.

TITLE: PASSIVE SOLAR RETROFIT

I.D. NUMBER: 054-781

REPORT AUTHOR: Robert J. Corbett

DATE WRITTEN: January 1980

PROJECT LOCALE: Butte

TOPICS: Passive solar, greenhouse

SUGGESTED AUDIENCE: General public, architects, engineers, builders

REPORT SUMMARY: The addition of a passive solar greenhouse to an existing concrete ore bin is described in depth. Despite the unique nature of the structure, the technology involved can be transferred with relative ease to more conventional dwellings. This report includes technical drawings, sketches, and a detailed discussion of system design, construction, testing and modification; glazing materials and installation; venting and air movement; excavation, footings and foundation; and framing. Report appendices and exhibits include technical data on materials and system used, analysis of construction methods, and design calculation worksheets.

TITLE: RESIDENTIAL SOLAR ADDITION

I.D. NUMBER: 056-811

REPORT AUTHOR: Dan Aadland

DATE WRITTEN: June 1982

PROJECT LOCALE: Absarokee

TOPICS: Passive retrofit, solarium, Trombe wall, heat storage

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: A 24 ft x 30 ft passive solar residential addition that uses a mass wall for both solar and wood heat retention is described. The report discusses the construction of the Trombe wall and Russian fireplace.

TITLE: PASSIVE SOLAR ENERGY FOR RESIDENTIAL SPACE HEATING

I.D. NUMBER: 134-771

REPORT AUTHOR: John W. Duffield

DATE WRITTEN: December 1980

PROJECT LOCALE: Missoula

TOPICS: Passive solar heat, Trombe wall, wood burning furnace, solar mass, direct gain

SUGGESTED AUDIENCE: General public, builders

REPORT SUMMARY: The construction and operation of a passive solar heating system that integrates a wood-burning furnace into a Trombe wall design is given a thorough treatment. An economic anlaysis addressing the costs and pay back potential of the systems is presented, as are tables depicting heating load and absorbed radiation. A diagram of the system is included.

TITLE: THREE RIVERS SENIOR CENTER ATTACHED SOLAR GREENHOUSE

I.D. NUMBER: 105-811

REPORT AUTHOR: Jeff Rupp, Tom D. Hinrichs

DATE WRITTEN: June 1982

PROJECT LOCALE: Three Forks

TOPICS: Solar greenhouse, water-tube storage, peaked-roof glazing

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: A small commercial size greenhouse, featuring water-tube storage and peaked-roof glazing, retrofitted to a senior citizen center is described. The report includes drawings of the greenhouse depicting the overhead glazing system, vertical south glazing made of tempered glass, insulated vents, solar chimney for ventilation and an insulated night curtain for cold weather.

SOLAR
Monitoring, Research and Modeling

TITLE: SOLAR HEATING SYSTEM PERFORMANCE MONITORING

I.D. NUMBER: 088-772

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: June 1980

PROJECT LOCALE: Selected sites in Montana

TOPICS: Performance monitoring

SUGGESTED AUDIENCE: General public, engineers

REPORT SUMMARY: This report consists of four parts; each addressing performance data and analysis for one of four residences monitored during the 1978-1979 heating season. A summary of thermal performance for the following is presented:

- A passive solar residence located near Bozeman using a water-wall, movable insulation and wood auxiliary heat;
- A residence in Hamilton retrofitted with an unconventional active-air solar system designed to be low in cost;
- A residence in Missoula retrofitted with an active-liquid solar system of free-standing collectors located 200 feet from the structure, and designed to provide both space heat and domestic hot water heat;
- A residence near Bozeman using an active air system combined with passive clerestory windows, internal masonry wall, and a natural gas furnace and wood stove supplying auxiliary heat.

* NOTE: Daily performance data for the four sites is on file at DNRC.

TITLE: SOLAR HEATING SYSTEM PERFORMANCE MONITORING

I.D. NUMBER: 145-800

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: October 1981

PROJECT LOCALE: Selected sites in Montana

TOPICS: FCHART analysis, performance monitoring

SUGGESTED AUDIENCE: General public, engineers

REPORT SUMMARY: The report is a compilation of six thermal performance monitoring studies conducted during the 1979-1980 heating season. The instrumentation consisted of computer-based data acquisition systems accepting the inputs from up to 40 transducers. The report contains performance summaries based on measured data results for the following:

- A residence retrofitted with active air collectors, using a heat pump for heat transfer from a remote heat storage. The house is a two-story wood-frame structure located near Bozeman having a floor area of 1,540 sq. ft., with an electric furnace and wood-burning fireplace as auxiliary heat;

- A mobile home near Missoula on which active air solar collectors were site-built and attached;

- An earth-sheltered house of 1,190 sq. ft. located near Miles City, having a passive sunspace and groundwater-to-air heat pump;

- A brick residence in Great Falls retrofitted with active liquid, tracking, concentrating solar collectors;

- A passive, earth-sheltered greenhouse of 6,400 sq. ft. located near Circle; and

- A residence near Conrad retrofitted with active liquid solar collectors roof-mounted and using adjustable reflectors with liquid storage tanks in the basement, and heat transmitted by natural conduction and convection.

* NOTE: Daily performance data for the six sites is on file at DNRC.

TITLE: SOLAR HEATING SYSTEM PERFORMANCE MONITORING

I.D. NUMBER: 147-811

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: April 1983

PROJECT LOCALE: Bozeman area

TOPICS: Performance monitoring

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: This report contains a discussion of three projects measured for system performance during the 1980-1981 winter heating season. Using the data obtained with a 40-channel, computer-based data acquisition system, a summary of thermal performance for the following is presented:

- A three-story commercial building near Bozeman having a total floor area of 55,000 sq. ft., containing large areas of south-facing glass, and using active liquid solar collectors for space heat and a gas-fired hot water boiler as an auxiliary system;

- A school building near Bozeman using an active liquid system with 3,880 sq. ft. of collector surface for space heating and domestic hot water; and

- A residence near Bozeman using a passive solar system of the double envelope design with a direct gain sunspace in the outer envelope.

A discussion of six other solar systems studied by using Class C methodology is included. The thermal performance of these systems is estimated by using a combination of the following components:

- Utility bill records for natural gas and electricity, other auxiliary fuel records and estimates, solar system description, size, principles of operation, owners' data and comments, data for load calculations, and solar radiation near the sites, with temperatures and degree-days.

TITLE: ENERGY/ECONOMIC ANALYSIS OF ACTIVE RESIDENTIAL SOLAR MODELS

I.D. NUMBER: 943-801

REPORT AUTHOR: Ted Plaggemeyer

DATE WRITTEN: July 1981

PROJECT LOCALE: Helena

TOPICS: Computer modeling, active solar, FCHART, SOLCOST

SUGGESTED AUDIENCE: Technical staff, researchers, engineers and individuals interested in simulation and modeling

REPORT SUMMARY: A review of two computer models that simulate active solar heating systems, FCHART and SOLCOST, is given. The two methods were found to yield similar predictions of annual solar fraction. Variables considered in the report are weather data, discount rate, tax credits, and energy forecasts. The report includes a sample program for a FCHART domestic hot water heating system and a SOLCOST residential system, as well as input parameters, default values, and Montana weather data for both models.

TITLE: SOLAR HOT WATER HEATING IN MONTANA: PERFORMANCE AND ECONOMIC ANALYSIS MODEL

REPORT AUTHOR: Danny Parker

DATE WRITTEN: May 1983

TOPICS: FCHART, computer modeling, solar domestic hot water

SUGGESTED AUDIENCE: Researchers, engineers, individuals interested in simulation and modeling

REPORT SUMMARY: The development of a computer program based on the FCHART method is described in this report. The program simulates the performance characteristics of solar domestic hot water systems. The discussion of the computer program includes: an analysis of hot water demand, a collector performance algorithm, an explanation of economic parameters, and a series of sensitivity tests.

TITLE DESIGN TESTING AND CONSTRUCTION OF AIR AND LIQUID SOLAR HEATING SYSTEMS

I.D. NUMBER: 140-771

REPORT AUTHOR: Richard Dill

DATE WRITTEN: May 1978

PROJECT LOCALE: Stevensville

TOPICS: Drain-down water heating systems, air collector absorber surfaces

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design, testing and installation of a drain-down system are described. Preliminary data on system performance and information on the system's cost are included. The report details the construction and testing of various air collectors, each having a different absorber surface—aluminum cans halved and quartered, aluminum screen, steel mesh with plaster-lath construction, copper stripping and fiberglass waves. The report addresses the performance of these materials and discusses the importance of air turbulence and distance between absorber surface and collector glazing.

TITLE: HANDBOOK OF SOLAR ENERGY EXPERIMENTS

I.D. NUMBER: 084-772

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: September 1979

PROJECT LOCALE: Bozeman

TOPICS: Solar experiments, insolation, absorptivity, solar radiation

SUGGESTED AUDIENCE: High school students and teachers

REPORT SUMMARY: The report contains ten solar collector experiments designed for use in the classroom and a background discussion of the basic concepts and mechanisms describing the sun's relationship to the earth. A list of materials needed and step-by-step instructions for each experiment are given.

TITLE: AN OVERVIEW OF THE SOLAR INSOLATION MEASUREMENT, MONTANA (SIMM) PROGRAM

I.D. NUMBER: 046-761; 084-772; 140-782

REPORT AUTHOR: Charless Fowlkes

PROJECT LOCALE: Statewide

TOPICS: Solar measurement, pyranometry, design data

SUGGESTED AUDIENCE: Technical staff, scientists

REPORT SUMMARY: This is a compilation of reports that describe the activities comprising the administration of the SIMM Program. The preparation and installation of the instrumentation, the measures used for collecting data, the procedures of reducing the computerized data, the documentation of the quality and accuracy of the data, and preparation of the manual are discussed. A technical examination of pyranometer types and calibration is presented, as is a description of statistical error analysis and data file structure. Included are several papers given before conferences that contain a discussion of data bases, tilt correction and weather data: "The Montana Solar Radiation Measurement Network," "Interfacing a $10 Calculator for Data Acquisition," and "Controlling the Accuracy of Solar Radiation Data From a Low Cost, 30 Station Network."

TITLE: MONTANA SOLAR DATA MANUAL, 1982 EDITION

I.D. NUMBER: 146-811

REPORT AUTHOR: Charless Fowlkes

PROJECT LOCALE: Thirty sites throughout Montana

TOPICS: Solar radiation, SOLMET, FCHART

SUGGESTED AUDIENCE: Engineers, architects

REPORT SUMMARY: This manual presents six years of average solar radiation data collected at approximately 30 sites throughout Montana. The report consists of the tables of solar radiation measured, tables showing the measured cloudy day statistics for the six years, and tables of climatological data from the National Weather Service records. Guidelines for using the solar data to size solar heating systems are included. The accuracy of the solar measurements, the use of FCHART, and a basic economic model are also discussed.

TITLE: MONTANA SUN RIGHTS - A SOLAR EASEMENT MODEL FOR RURAL SUBDIVISIONS

I.D. NUMBER: 086-772

REPORT AUTHOR: Thomas Stewart, Eileen Shore

DATE WRITTEN: May 1980

PROJECT LOCALE: Helena

TOPICS: Solar easement, subdivision, legal measures

SUGGESTED AUDIENCE: General public, builders, architects, land use planners

REPORT SUMMARY: The report presents a study which considers the problem of defining and establishing a solar easement over a residential subdivision area. A technical discussion of shading caused by structures or objects of various heights on lots of various topography and orientations is given. Also included is an examination of the legal aspects of developing an easement that would protect a landowner's rights to unobstructed sunlight. The analysis is specific to the Helena area, but would be applicable to other rural residential subdivisions in Montana containing lots of 1/2 acre or larger.

TITLE: MONTANA WIND ENERGY RESEARCH AND DEVELOPMENT PROGRAM

I.D. NUMBER: 203-782

REPORT AUTHOR: MERDI, Inc.

DATE WRITTEN: June 1981

PROJECT LOCALE: Livingston, Whitehall, Big Timber

TOPICS: Wind-monitoring, small wind energy conversion systems

SUGGESTED AUDIENCE: General public, wind machine developers

REPORT SUMMARY: The wind resource monitoring performed from March 1980 through February 1981 at selected sites near Whitehall, Big Timber and Livingston is given a thorough treatment. The recording devices installed, Campbell Scientific CR 21 Micrologger Equipment, and the meter towers are described. The report contains graphs of the data collected, depicting biweekly and monthly average wind speeds, monthly average power density, monthly and yearly wind speed frequency distribution and yearly wind direction frequency distribution for the three sites. The report also discusses the second phase of the project: the installation and performance monitoring of a 25 kW Jay Carter small-scale wind energy conversion system (SWECS) near Livingston. Also presented are an economic evaluation of the SWECS, a prediction of the value of electricity that could be generated at the site, and a comparison between the measured generator output and the theoretical calculated output.

* NOTE: Tables of raw data gathered from the three sites are on file at DNRC.

TITLE: WIND RESOURCE ASSESSMENT: TRACY, MONTANA

I.D. NUMBER: 235-761

REPORT AUTHOR: Alex G. Drapes, Drapes Engineering

DATE WRITTEN: June 1977

PROJECT LOCALE: Tracy

TOPICS: Wind resource assessment

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The report documents the wind resource assessment performed at Tracy, Montana by Drapes Engineering. Wind speed, wind direction, insolation, and ambient temperature were monitored at the Tracy site during April, 1977. The results of these measurements were correlated with the Weather Bureau wind speed records for the same period at the Great Falls Airport.

TITLE: LIVINGSTON WIND ENERGY SYSTEM: A MUNICIPAL COMMERCIALIZATION PROJECT: JUNE 1981 - NOVEMBER 1982

I.D. NUMBER: 241-811

REPORT AUTHOR: Ed Stern, Paul Laird

DATE WRITTEN: December 1982 - (chart data to July 1983)

PROJECT LOCALE: Livingston

TOPICS: Wind farm, 25 kW wind generator

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design, construction and start-up phase of the project located on the bench area one mile northeast of Livingston, commonly known as the "Livingston Wind Farm," is addressed. The report describes the installation and operation of four 25-kW Jay Carter wind generators, each having an individual control system, electrical interface system, and inter-connected as a unit with the Montana Power Company electrical grid. The components discussed include site selection, project expenses, problems encountered and a performance chart for each of the four generators from December 1982-July 1983.

TITLE: WIND RESOURCE ASSESSMENT: LIVINGSTON-SPRINGDALE AREA

I.D. NUMBER: 212-781

REPORT AUTHOR: Don Brelsford, Brelsford Engineering

DATE WRITTEN: August 1979

PROJECT LOCALE: Livingston

TOPICS: Wind resource assessment

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The report documents the wind resource assessment performed at nine sites in the Livingston-Springdale area. Wind speed was monitored at each site for a one-to-three month period. Mean wind speed, power-density and wind speed frequency spectra covering the study period are given for each site. For long-term predictions, the mean wind speeds of each site are correlated with the U.S. Weather Bureau wind speed records for the same period at the Livingston Municipal Airport, Mission Field.

TITLE: RESEARCH IN THE DEVELOPMENT OF INTEGRATED WINDPOWER SYSTEMS AND SYNCHRONOUS INVERTERS

I.D. NUMBER: 220-761, 201-771

REPORT AUTHOR: V. Hugo Schmidt

DATE WRITTEN: February 1978, August 1979

PROJECT LOCALE: MSU Campus in Bozeman

TOPICS: Synchronous inverters

SUGGESTED AUDIENCE: Technical staff, researchers, engineers

REPORT SUMMARY: These two reports describe Dr. Schmidt's research in the development of small, economically competitive wind systems for generating electricity from windpower. The design and testing of synchronous inverters for converting wind-generated direct current power to alternating current is discussed. A summary of three different types of wind rotors and alternator drive trains is given. A discussion of methods of providing for vertical axis rotation, an explanation of the bench test apparatus used, test results and a summary of field tests of the three systems are included. A description of other types of wind systems, including induction motors, vortex systems, bicycle-wheel-like rotors, variable-speed, and constant frequency alternators is also presented.

BIOMASS
Liquid and Alcohol Fuels

TITLE: LIQUID BIOFUELS IN MONTANA - ASSESSEMENT OF THE OIL SEED RESOURCE

I.D. NUMBER: DPRA-595

REPORT AUTHOR: Geneva Hammaker et al.

DATE WRITTEN: February 1983

PROJECT LOCALE: Statewide

TOPICS: Vegetable oils, oilseed production, diesel fuel substitutes, biomass

SUGGESTED AUDIENCE: Researchers, technical biologists, agronomists

REPORT SUMMARY: An inventory of currently cultivated, native and naturalized Montana oil-bearing species is developed, using tables to summarize the information gathered. The results of single-season plant sampling and testing for vegetable oil are discussed, and soil association and land cover are examined for cropping potentials. The costs of planting, cultivating and harvesting are addressed. Several of the native or naturalized species were found to warrant further investigation as potential whole-plant-oil crops. In the depressed agricultural market of October, 1982, the production costs of oilseeds compared favorably with that of small grains.

TITLE: DEMONSTRATION OF AN ALCOHOL FUEL PLANT AND STRAW BOILER

I.D. NUMBER: 437-811

REPORT AUTHOR: Larry Bronec, Charles Bronec

DATE WRITTEN: June 1983

PROJECT LOCALE: Geraldine

TOPICS: Fuel ethanol, gasohol, biomass, straw-fired boiler, distillers dried grain

SUGGESTED AUDIENCE: General public, engineers, farmers

REPORT SUMMARY: The report desribes the innovative approach taken in constructing a 20 gallon/hour fuel ethanol plant using a straw-fired 50 horsepower boiler of about 80% efficiency to supply the process heat. A description of the cook tanks, which are made of epoxy coasted galvanized steel, and the dehydrator molecular sieves is given. Also included are a process description, equipment specifications, plant costs and drawings.

* NOTE: Working drawings of the plant layout are on file at DNRC.

TITLE: FUEL ETHANOL PLANT NEAR AMSTERDAM, MONTANA

I.D. NUMBER: 457-811

REPORT AUTHOR: Bruce Kania, A.E. Montana, Inc.

DATE WRITTEN: December 1981

RPOJECT LOCALE: Amsterdam

TOPICS: Fuel alcohol, distillers dried grain, gasohol

SUGGESTED AUDIENCE: General public, economists, developers

REPORT SUMMARY: The design and construction specifications, equipment costs, and conceptual drawings for a 660,000 gallon/year ethanol facility is described. The report covers start-up problems, marketing and continuing by-product research for ethanol produced from barley or wheat. A discussion of the use of molecular sieves for drying 190 proof ethanol is included.

* NOTE: Working drawings of the plant layout are on file at DNRC.

TITLE: AMBIENT TEMPERATURE STARCH HYDROLYSIS FOR BARLEY

I.D. NUMBER: 417-821

REPORT AUTHOR: Renewable Technologies, Inc.

DATE WRITTEN: October 1983

PROJECT LOCALE: Butte

TOPICS: Gasohol, starch hydrolysis, fermentation, alcohol fuel

SUGGESTED AUDIENCES: Technical researchers, alcohol fuel plant operators

REPORT SUMMARY: The report summarizes the research and development of a process for enzymatic hydrolysis and fermentation of raw starch for use in alcohol fuel production. This process will potentially reduce alcohol fuel production costs and increase energy efficiency by eliminating the energy intensive starch cooking step. This research addresses the selection of mold for enzyme production, design of mold culture systems, development of a fermentation process, evaluation of raw barley starch hydrolysis enzymology, laboratory techniques, energy analysis and costs of developing the process.

TITLE: FUEL ETHANOL AND TORULA YEAST FROM CONIFEROUS WOOD BIOMASS — THOMPSON FALLS, MONTANA

I.D. NUMBER: 4ll-801

REPORT AUTHOR: Gary Kent, Stuart Kilgore, Don Brelsford, Daniel Parks

DATE WRITTEN: May 1981

PROJECT LOCALE: Thompson Falls

TOPICS: Fuel ethanol, modified Madison process

SUGGESTED AUDIENCE: Forestry managers, economists, researchers

REPORT SUMMARY: The feasibility of a fuel grade ethanol plant at Thompson Falls, reviewing the Scholler, Madison, and Lawrence Berkely Laboratory hydrolysis processes for converting wood to alcohol is discussed.

The process developed in the study uses hogged fuel chips and proceeds through the process modules of autohydrolysis, lignin extraction, pre-hydrolysis, hydrolysis concentration, fermentation, binary distillation, and dehydration to produce the fuel grade ethanol (FGE). The report includes a wood resource analysis, process review, conceptual engineering plan, marketing and economic analysis, and five possible plant configurations. The recommended plant configuration would use 850 oven-dry tons of wood/day to produce 2.4 million gallons/yr of FGE, 2,300 tons/yr Torula Yeast and 5 megawatts of cogenerated electricity.

TITLE: LOW ENERGY ETHANOL DEHYDRATION VIA BARLEY ADSORBPTION

I.D. NUMBER: 441-811

REPORT AUTHOR: James Law, Warren P. Scarrah

DATE WRITTEN: January 1983

PROJECT LOCALE: MSU Campus in Bozeman

TOPICS: Biomass, gasohol, ethanol, fuel alcohol

SUGGESTED AUDIENCE: Researchers and tinkerers

REPORT SUMMARY: The report addresses the feasibility of using barley as an adsorbent to dehydrate the ethanol-water mixture from distillation to nearly absolute ethanol (99wt%). The laboratory research is in-depth and includes a discussion of the use of process variables, experimental design, criteria for evaluation, equipment and procedures.

This research found ethanol dehydration to be feasible with a drying capacity of about 0.0072 gal 99wt% ethanol/lb adsorbent barley. The report contains experiment results, graphs, analysis and the design of a one gallon per hour unit for on-farm use.

TITLE: FUEL ETHANOL PRODUCTION BY FERMENTATION IN INTERMEDIATE-SIZED PLANTS

I.D. NUMBER: 430-800

REPORT AUTHOR: MERDI

DATE WRITTEN: June 1981

PROJECT LOCALE: Butte

TOPICS: Fuel ethanol, gasohol, fermentation, biomass

SUGGESTED AUDIENCE: General public, economists, farmers

REPORT SUMMARY: A broad view of the technology of ethanol production and an in-depth description of process technology and process equipment are presented. Sugar, starch and cellulose feedstocks are examined. A description of the ethanol through fermentation process is given. Developing technology, as well as state-of-the-art, is discussed, and a treatment of the marketing of products is included. The study addresses intermediate plant capacity sizes: from 500,000 to 5,000,000 gallons per year.

TITLE: AN EMPIRICAL STUDY ON THE USE OF STRAIGHT ALCOHOL FUELS PREPARED FROM FEEDSTOCK INCLUDING BARLEY, WHEAT, AND POTATOES

I.D. NUMBER: 423-801

REPORT AUTHOR: William Dratz and Dan Miles

DATE WRITTEN: September 1980

PROJECT LOCALE: Lake County

TOPICS: Farm-scale still, ethanol production, agricultural feedstocks, biomass

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The designing and erecting of a 100 gallon/day still and the testing of the ethanol yield of various feedstocks are addressed. Included are a survey of agricultural feedstock in the lower Flathead Valley and a plant design and equipment list for the development of a proposed 600-1,000 gallon/day still. The environmental effects, health considerations, and socioeconomic factors in the local production of ethanol for use in Lake County are examined. A description of typical ethanol production, including schematics, is presented.

TITLE: PROCEEDINGS - A PUBLIC FORUM - BIOFUELS AND OTHER ALTERNATE ENERGY

I.D. NUMBER: 711-811

DATE WRITTEN: April 1981

PROJECT LOCALE: Bozeman

TOPICS: Production of yeast, alcohol and methane from renewable materials - wind, sun, biomass

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: This report consists of transcripts of speeches given at the Biofuels and Other Renewable Energy Forum held in November 1980 at the Montana State University Campus. The forum was oriented toward farmers and ranchers in Montana, the related agri-business audience and other Montanans interested in biomass and other areas of renewable energy. Some of the topics covered by the report include:

- The potential of on-farm alcohol productions;
- The economics and energy balance of producing alcohol;
- The use of Montana crops for energy;
- The nutritional aspects of the by-products of alcohol production through animal feed programs and the potential for human food products; and
- Other renewable energy sources such as wind, solar, hydropower and geothermal energy.

TITLE: ELECTRIC GENERATION HOME WOOD-FIRED STEAM ENGINE

I.D. NUMBER: 301-821

REPORT AUTHOR: Robert Stoeckley

DATE WRITTEN: September 1983

PROJECT LOCALE: Eureka

TOPICS: Biomass, combustion, small power production

SUGGESTED AUDIENCE: General public, tinkerers

REPORT SUMMARY: The report describes the construction and testing of a 12-volt direct current electric generation system for a rural Montana home. Test results and analysis are included for a 7 horsepower wood-fired steam boiler that powers either a prototype steam engine or commercially available steam turbine that generates electricity. The report contains a technical description, system drawings, operating procedures, economics, test results, conclusions and recommendations.

TITLE: DEVELOPMENT OF AN EFFICIENT FIREPLACE INSERT STOVE

I.D. NUMBER: 322-811

REPORT AUTHOR: Richard G. Wrench

DATE WRITTEN: April 1982

PROJECT LOCALE: Kalispell

TOPICS: Fireplace insert, afterburner, combustion

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design, construction and testing of a fireplace insert wholly contained within the fireplace cavity is discussed. The report describes the three operational modes in which the insert can be used: as a conventional fireplace, as an airtight, double walled, forced air insert, and as a secondary combustion chamber (afterburner). The report contains the monitoring results of the fuel, convection air, and radiant heat analyses of the unit. An economic assessment and drawings of the fireplace insert are also included.

TITLE: **FIRE TUBE WOOD BOILER FOR DOMESTIC USE**

I.D. NUMBER: 374-761

REPORT AUTHOR: Doug Polette

DATE WRITTEN: July 1978

PROJECT LOCALE: Bozeman

TOPICS: Firetube, wood boiler

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design, construction and testing of a wood-fired boiler used in conjunction with a heat storage unit for heating a single-family dwelling is addressed. The report includes a discussion of modifications made to the unit, and an assessment of the system's performance. Using rates in effect at that time, a cost comparison for the use of wood and electricty is given.

TITLE: **TIMBER THINNING PROJECT FOR UTILIZATION OF WOOD RESIDUE**

I.D. NUMBER: 317-811

REPORT AUTHOR: Sherwin K. Smith, Hank Goetz

DATE WRITTEN: March 1982

PROJECT LOCALE: Blackfoot Valley, Missoula County

TOPICS: Biomass utilization, wood handling equipment, timber utilization

SUGGESTED AUDIENCE: General public, landowners and land managers

REPORT SUMMARY: The results of a field trial in western Montana in which precommercial forest thinnings were processed by a portable whole tree chipper is discussed. Thinnings were conducted on 163 acres of second growth stands of primarily ponderosa pine heavily infested by the Mountain Pine Beetle. The report analyzes the production methods and costs of thinning and chipping systems. Also addressed are details on energy use and yield analysis, system cost, economic evaluation of full tree chipping and the environmental aspects of the project. The report contains specifications and drawings developed for a tractor mounted, 3-point hitch grapple system.

TITLE: A THREE MEGAWATT BIOMASS-FIRED COGENERATION PLANT FEASIBILITY STUDY

I.D. NUMBER: FL-651

REPORT AUTHOR: Miller Brice, General Electric, Portland

DATE WRITTEN: July 1983

PROJECT LOCALE: Thompson Falls

TOPICS: Cogeneration of electricity-sawmills, wood waste

SUGGESTED AUDIENCE: Wood-products industry personnel, engineers

REPORT SUMMARY: The report is a feasibility study for a cogeneration plant designed to replace a wood-fired boiler currently providing process steam to a sawmill operation (14 million to 17 million board feet a year). The cogeneration plant would include a larger boiler that would provide additional steam to power a 3.0 MW (net) generator. In addition, the facility would eliminate the need for three teepee burners in the area. The feasibility study includes a fuel supply analysis, plant size and configuration, cogeneration considerations, an economic analysis, implementation and planning considerations, conclusions and recommendations.

TITLE: FEASIBILITY AND DESIGN STUDY - 240 TON PER DAY WOOD REFINING DENSIFICATION FACILITY WITH 2.0 MEGAWATTS COGENERATION FOR EUREKA, MONTANA

I.D. NUMBER: 467-811

REPORT AUTHOR: Eagle Energy Systems, Inc.

DATE WRITTEN: April 1983

PROJECT LOCALE: Eureka

TOPICS: Wood waste usage, forest slash usage, cogeneration, biomass

SUGGESTED AUDIENCE: General public, air pollution controllers, foresters

REPORT SUMMARY: The technical and economic feasibility of constructing a facility using waste wood to manufacture wood pellets as a low pollution fuel in domestic wood stoves and industrial boilers is explored. Economic analyses for an 11 ton per hour facility with a 2 megawatt capacity of cogenerated electricity are presented. Capital costs, operating costs, financing methods, equipment specifications and marketing considerations based on 1982 dollars are included. The conclusion drawn is that a facility of that size is environmentally and technically feasible at an operating capacity of at least 70 percent. Small geographically dispersed facilities in western Montana were found to be economically feasible.

TITLE: AN INVESTIGATION INTO UTILIZING WOOD WASTE IN THE LEWIS AND CLARK COUNTY AREA FOR SPACE HEAT IN MEDIUM-SIZED BUILDINGS

I.D. NUMBER: 301-801

REPORT AUTHOR: Herbert C. Winsor

DATE WRITTEN: November 1980

PROJECT LOCALE: Helena

TOPICS: Densification, wood combustion, boilers

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The feasibility of using wood waste from slash piles in the Helena area as a boiler fuel in medium-sized institutions is discussed. The report looks at retrofitting existing heating systems and touches on the environmental and ecological concerns, storage aspects, boiler options and economic possibilities. Also addressed are the options of densification and direct combustion. The conclusion drawn in the report is that the feasibility of using slash wood in this application is very questionable.

TITLE: CITY OF HELENA: EVALUATION AND DESIGN OF SOLID WASTE RESOURCE RECOVERY FACILITY

I.D. NUMBER: 311-800

REPORT AUTHOR: Richard Frounfelker, Joseph Swartzbaugh

DATE WRITTEN: March 1982

PROJECT LOCALE: Helena

TOPICS: Garbage-burning facility, energy recovery system

SUGGESTED AUDIENCE: City and county planners, solid waste supervisors

REPORT SUMMARY: The technological and economic feasibility of constructing a garbage-burning facility and energy recovery system for the City of Helena is addressed. The two sites studied in detail in the report are the Capitol complex and Fort Harrison site. Cogeneration for the Capitol complex is also discussed. The conclusions drawn were that the Capitol complex was the more promising location for the facility because of its greater energy demand. However, either facility was found to be only marginally feasible given 1981 landfill and energy cost situations.

TITLE: CENTRAL BIOMASS COMBUSTION FACILITY FEASIBILITY STUDY

I.D. NUMBER: 303-782

REPORT AUTHOR: Charles Crane, MERDI, Inc.

DATE WRITTEN: July 1982

PROJECT LOCALE: Statewide

TOPICS: Biomass utilization, straw, bioenergy

SUGGESTED AUDIENCE: General public, ranchers and farmers, researchers

REPORT SUMMARY: The feasibility of the use of crop residues (wheat straw) as an energy feedstock for a central heating plant is addressed. The following are discussed: agronomic contraints to biomass production, collection and transport of crop residues to the proposed facility, and the processing and combustion technologies feasible for the proposed facility. The report determined that the use of straw as an energy feedstock for central heating plants in Montana is technically feasible, but not economically feasible at the time. The report indicates that straw may be a possibility as a fuel source for smaller dispersed users, specifically for some individual home heating systems in certain areas of Montana.

TITLE: MONTANA BIOMASS COGENERATION MANUAL: A WORKSHOP HANDBOOK

I.D. NUMBER: SRC-653

REPORT AUTHOR: Dilip R. Limaye, Shahzad Qasim, Howard E. Haines

DATE WRITTEN: May 1983

PROJECT LOCALE: Missoula

TOPICS: Biomass cogeneration, wood wastes, municipal solid wastes, agricultural wastes, animal wastes

SUGGESTED AUDIENCE: General public, engineers, developers, forest industry personnel

REPORT SUMMARY: This report was prepared as a manual for use at the Biomass Cogeneration Workshop held in May 1983 in Missoula, Montana. Various principles and applications for cogeneration and biomass utilization are summarized. The following are addressed:

- biomass as an energy resource
- cogeneration technologies
- biomass energy resources, specifically wood wastes, municipal solid wastes, agricultural wastes, animal wastes
- biomass energy recovery technologies, specifically, direct combustion, gasification, and anaerobic digestion
- economic assessment of cogeneration systems

The report also contains overview of state and federal regulations relating to cogeneration and a resource list applicable to the Pacific Northwest.

BIOMASS
Biogas

TITLE: A COMPREHENSIVE SURVEY OF BIOLOGICAL METHANE PRODUCTION FROM AGRICULTURAL, DOMESTIC AND INDUSTRIAL RESOURCES OF MONTANA

I.D. NUMBER: 402-772, 402-782, 435-811

REPORT AUTHOR: David M. Ward, Principal Investigator

DATE WRITTEN: Completed July 1982

PROJECT LOCALE: MSU campus in Bozeman

TOPICS: Anaerobic digestion, manure, methane, hot spring algal-bacterial mats

SUGGESTED AUDIENCE: Researchers, biochemists

REPORT SUMMARY: Three reports provide a detailed discussion of laboratory research on the production of methane from cow and pig manure. The research is primarily microbiological. The reports include an investigation of methane generation by algae and bacteria in hot springs in Yellowstone Park.

TITLE: RESEARCH INTO THE FACTORS EFFECTING THE BIOCONVERSION OF CATTLE MANURE AND CELLULOSIC MATERIAL MIXTURES TO BIO-GAS

I.D. NUMBER: 486-761, 401-772, 403-782, 404-801, 458-811

REPORT AUTHOR: John E. Robbins, Melvin T. Armold

DATE WRITTEN: Completed July 1982

PROJECT LOCALE: MSU Campus in Bozeman

TOPICS: Bio-gas, methane, anaerobic digestion, cellulose, manure, biomass

SUGGESTED AUDIENCE: Researchers, biochemists

REPORT SUMMARY: The five reports are a technical analyses of Professor Robbins' experimental research into the process of converting manure and waste into a bio-gas energy fuel. The reports address several chemical factors affecting the conversion to methane in anaerobic digestion. Specifically discussed are factors that increase the efficiency of the bioconversion process, and factors that increase the stability of the digesters. This research indicates that cellulosic material mixed with manure holds promise for increased methane production.

TITLE: BIOGAS CONVERSION ASSESSMENT PROJECT

I.D. NUMBER: 412-781

REPORT AUTHOR: John McBride, Lauren McKinsey, et al.

DATE WRITTEN: December 1979

PROJECT LOCALE: Bozeman

TOPICS: Methane, bio-gas, manure, digester

SUGGESTED AUDIENCE: General public, dairymen, ranchers

REPORT SUMMARY: The general feasibility of operating a methane digester in Montana using manure or other agricultural waste is discussed. The report includes an in-depth evaluation of the available bio-gas generation technology, and a description of a preliminary design for a prototype methane digester proposed for the MSU dairy production center.

TITLE: PROCEEDINGS - METHANE/BIOGAS CONFERENCE

I.D. NUMBER: 712-821

DATE WRITTEN: March 1982

PROJECT LOCALE: Kalispell

TOPICS: Design, installation and operation of methane digesters on dairy farms, biomass, biogas

SUGGESTED AUDIENCE: General public, farmers and ranchers

REPORT SUMMARY: This report consists of excerpts of the presentations given at the Methane/Biogas Conference held in March 1982 in Kalispell, Montana. Topics specifically addressed are:

- Dairy methane production, systems, storage and slurry utilization;
- Agricultural methane production systems, storage, slurry options, ethanol, methane integration;
- Engineering design, material and energy balances, site considerations, materials of construction and operation, maintenance programs; and
- Use of surplus gas, markets for gas and by-products, financing, specific problems.

GEOTHERMAL

TITLE: GEOTHERMAL FORCED-AIR HEATING SYSTEM FOR A RESIDENCE

I.D. NUMBER: 559-761

REPORT AUTHOR: Frank D. Gruber, William M. Spilker

DATE WRITTEN: October 1980

PROJECT LOCALE: Helena

TOPICS: Geothermal, hot water, heat exchangers, forced air

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The construction and operation of a geothermal heating system providing heat for a forced-air furnace and domestic hot water for a 1,000 sq. ft. house located west of Helena is discussed. The report describes system costs and performance. The system consists of a well and Jacuzzi pump, black iron piping from the well to the house, finned-tube hot water coils installed in the furnace plenum, and a solar hot water heater retrofitted to use geothermal water. Resource information is also included and a temperature and chemical analysis of the geothermal resource is given.

TITLE: GEOTHERMAL HEATING SYSTEM FOR THE FIRST NATIONAL BANK OF WHITE SULPHUR SPRINGS, MONTANA

I.D. NUMBER: 503-771

REPORT AUTHOR: Michael Grove (Darrel E. Dunn)

DATE WRITTEN: August 1980

PROJECT LOCALE: White Sulphur Springs

TOPICS: Geothermal, space heating, direct use, hot water, heat exchangers, well drilling

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The design and installation of a geothermal heating system providing 80% of the heat for a bank building is described. The report contains a brief discussion of the performance and economics of the heating system. The system pumps 127°F water from the 395-foot level of a well drilled approximately 100 feet from the bank, and uses a maximum flow of 65 gallons per minute. In addition, the geologic and hydrologic data obtained from the production well is presented.

TITLE: CONSTRUCTION OF GEOTHERMAL/SOLAR HYBRID GREENHOUSE ON WARM SPRINGS CREEK IN AVON, MONTANA

I.D. NUMBER: 653-811

REPORT AUTHOR: Tom and Lisa Harpole

DATE WRITTEN: October 1982

PROJECT LOCALE: Avon

TOPICS: Geothermal-solar hybrid greenhouse

SUGGESTED AUDIENCE: General public, horticulturists

REPORT SUMMARY: The use of a geothermal resource to heat a greenhouse used for growing food throughout the year is described. The report details the construction of the 16-by-47 foot geothermal-solar hybrid greenhouse built with high quality insulating materials. The 65-90°F water, flowing at 40 gallons per minute, moves through a 2-inch CPVC pipe embedded in the pea-gravel floor. The analysis includes a comprehensive photo-history of the project, and a projection of the economic benefits of growing plants for sale.

TITLE: GEOTHERMAL EVALUATION AND WELL DEVELOPMENT OF THE CAMP AQUA SITE

I.D. NUMBER: 551-811

REPORT AUTHOR: Thor Jackola, Jackola Engineering

DATE WRITTEN: August 1982

PROJECT LOCALE: Hot Springs, Montana

TOPICS: Geothermal, resource evaluation, production well, temperature-gradient

SUGGESTED AUDIENCE: Researchers, resource developers

REPORT SUMMARY: The geothermal resource evaluation conducted at the Camp Aqua well drilling site is presented. The report details the drilling of the temperature gradient hole, production well drilling, water quality analysis, and hydrology of the area. Data and specifications of the production well are included, revealing a temperature measurement of 135°F logged at the 234-ft level, with the well flow measurement at 1,160 gallons per minute.

TITLE: PRE-FEASIBILITY DRILLING OF GEOTHERMAL WELL NEAR BOZEMAN HOT SPRINGS TO DETERMINE EXTENT OF GEOTHERMAL RESOURCE.

I.D. NUMBER: 500-782

REPORT AUTHOR: Charles Page

DATE WRITTEN: January 1981

PROJECT LOCALE: Bozeman

TOPICS: Geothermal, well drilling, hot water, flow testing, high pressure drilling techniques

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: This report summarizes the preliminary assessment of the geothermal resource at Bozeman Hot Springs. The report contains a description of the procedures used at the site for drilling the test well and production well, an economic evaluation, and geologic and hydrologic information about the site.

TITLE: GEOPHYSICAL INVESTIGATION OF THE AREA AROUND WARM SPRINGS STATE HOSPITAL TO DELINEATE POSSIBLE AREAS FOR DISCOVERY OF GEOTHERMAL RESOURCES

I.D. NUMBER: 515-781

REPORT AUTHOR: Charles J. Wideman

DATE WRITTEN: January 1980

PROJECT LOCALE: Warm Springs

TOPICS: Geothermal, hot water, geophysics, gravity, magnetic and resistivity surveys, Warm Springs heating project

SUGGESTED AUDIENCE: Researchers, resource developers

REPORT SUMMARY: The report summarizes a geophysical survey conducted near the Warm Springs State Hospital to gather information on the structure of the geothermal system underlying the area. Also addressed are the delineation of the subsurface geothermal structure, the field surveys performed, procedures and data reduction techniques used. A gravity data map and a resistivity map are included. The results of the geophysical survey were used to plan the drilling of a production well for a geothermal heating project at Warm Springs.

HYDROPOWER

TITLE: HYDRO-ELECTRIC TURBINE PROJECT

I.D. NUMBER: 601-801

REPORT AUTHOR: Rick & Earlene Ostberg

DATE WRITTEN: December 1982

PROJECT LOCALE: Power

TOPICS: Low head hydro, hybrid Pelton, induction, small power producer

SUGGESTED AUDIENCE: General public

REPORT SUMMARY: The installation of a hybrid Pelton/low head hydro turbine using irrigation drain water to supply the electrical needs of a farm is detailed in depth. The report addresses the acquisition, testing and performance of the system and provides a cost summary and economic analysis. Also described is the interconnecting of the induction system with the Sun River Rural Electric Cooperative; useful conclusions and recommendations are drawn.

* NOTE: Working drawings of the system are on file at DNRC.

TITLE: PERFORMANCE OF FEASIBILITY STUDIES AND SYSTEM DESIGN ANALYSIS AT SIX POTENTIAL MICROHYDRO SITES

I.D. NUMBER: 650-810

REPORT AUTHOR: Richard Wrench

DATE WRITTEN: January 1982

PROJECT LOCALE: Selected sites in Montana

TOPICS: Microhydro generation

SUGGESTED AUDIENCE: General public, engineers

REPORT SUMMARY: This report is a series of technical engineering studies assessing the potential for microhydropower generation at six proposed sites. The individual sites studied are near Cardwell, Shawmut, Ronan, Bigfork, Big Timber, and Bozeman. Each study discusses the feasibility of the site, methodology employed, data gathered, hydrological and environmental considerations, and conclusions drawn.

TITLE: A MARKETING PLAN FOR ENERGY OUTREACH ACTIVITIES

REPORT AUTHOR: ECO Northwest, Ltd.

DATE WRITTEN: May 1983

TOPICS: Consumer use, audience acceptance, awareness levels, energy conservation, renewable energy

SUGGESTED AUDIENCE: Energy planners and program managers

REPORT SUMMARY: During late 1982 and early 1983, ECO Northwest conducted a series of surveys for the Department of Natural Resources and Conservation to improve the distribution of its energy outreach and information programs. Separate surveys were conducted among the public, farmers and ranchers, large and small businesses, builders, architects, lenders, appraisers, and realtors. The final report contains survey methodology, selection and sampling techniques, questionnaires, survey results and conclusions.

TITLE: MONTANA COMMERCIAL SECTOR STUDY

REPORT AUTHOR: Danny Parker, Lynda Steele

DATE WRITTEN: Spring 1983

TOPICS: Commercial sector, energy consumption studies

SUGGESTED AUDIENCE: Technical staff, program managers, utility analysts, school and hospital administrators

REPORT SUMMARY: This report consists of three papers describing a proposed study to estimate the electrical conservation potential of Montana's commercial sector.

One section contains a multi-phase analysis based on stratified sampling. A survey of 500-1,000 commercial buildings is proposed. The square footage of the structures would be identified and these buildings would then be grouped into strata based on their annual electrical consumption. Buildings from each strata would then be selected, given an energy audit, and their conservation potential determined using currently available computer models. Standard statistical methods will be used to draw and analyze a small audit sample of 100 units. Conclusions can be drawn from the square footage data that will be relevant to the commerical sector.

A second section of this report presents an overview of the Montana commercial sector; a third section contains slight modifications to the study design based on the experiences of other professionals in the western United States who are studying commercial sector conservation potential.

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ENERGY DIVISION
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